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Method to the evaporation of liquids, in particular

of radioactive effluents
The invention relates to a method to the evaporation of liquids, in particular of radioactive effluents, by means of multistage evaporation plants.

The requirements to the purity of the effluents from nuclear plants, like particularly from nuclear power stations, become ever higher. So far still residual activities of -6 10 6 Curie/m3 could become allowed, however values up to 10 8 Curie/m3 than residual activities become required in newer time.

After that there are states of the art first single-step plants, their standard equipment from an evaporator with Abstreiferkplonne, an air condenser to the condensation of the vapours (distillate), expenditure-steamed, a distillate deaerator and a distillate radiator exists. Various evaporator types in such plants used became, among other things

Thin section evaporator with movable wiper blades, pot evaporators, natural circulation evaporators as well as evaporators with obligation circulation. All these plants work preferably bottom normal pressure, thus at a boiling temperature from 100 to 1050C and with a heating steam temperature of 1300C and over.

Adverse one at these single-step plants is it that the quality of their distillate is not sufficient for no more the present requirements. In addition the direct heating of the evaporators with high tensioned leads, mostly superheated steam to a rapid incrustation of the heating surfaces.

Further two-stage d.c. plants are known.

Kind this plant works after Böhler methods, with which from the first evaporation stage, becomes concentrated in which the effluent, vapours become the heating of the second evaporation stage removed. These vapours are struck down in a mixing condenser by the liquid umgepumpte in the second evaporation stage and with the same mixed. The evaporation in the second stage made by relaxation of the circumferential liquid. So that this liquid does not become by ago over-clever from drops from the first stage concentrated, a part must become into the first stage recycled.

Another kind of the known two-stage evaporation plants are such, which serve for the generation of Bi-distillate for pharmaceutical purposes. These plants exhibit known rotating or pot evaporators, which is in direct current circuit disposed partially one above the other. With the procedure of these evaporation plants the raw water of the first evaporation stage becomes supplied, and the vapours from this stage become the heating of the second stage used.

These two-stage d.c. plants have a number of disadvantages, which are to be seen in particular in the fact with use for effluents that the effluent in the first stage, which can be regenerated, becomes concentrated with higher temperatures, whereby an increased incrustation danger results. With the two-stage plants, which work with mixing condensation, distillate must become recycled, around an enrichment on e.g. To avoid radioactivity. In addition it comes when starting and during the pressure maintenance due to the direct warm one transmission in the second stage to difficulties, and there is large circulation pumps required, before all things with at present required large evaporation achievements.

For example it is during an evaporation achievement of 6 t/h and a boiling temperature of e.g. 1150C in the first stage with a relaxation of the circulated liquid on 1000 C required to roll an amount over of over 200 m3/h. Are the temperatures lower to lie, e.g. 1080C, whereby the relaxation on 1000C made is, then it already necessary to roll an amount over of 400 m3/h. The electrical power which can be applied rises corresponding.

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With the invention a method is to become the evaporation of liquids, in particular the decontamination of RA dioaktiven effluents, provided, which is more operable economic, with safety the required high purities of the distillate furnishes and little maintenance as required as possible; further also the other indicated above disadvantages are to be overcome with the invention process.

To the solution of this object will proposed to out-arrange that in such a way according to invention initially mentioned methods that one those; Liquid in or the several first stage the subsequent stages, preferably in or several last stages, the evaporation plant evaporates and in combination thereby the vapour condensate of these, preferably the latter, stage and/or. Stages in or several these stages and/or.

these stages evaporates preceding stages to the achievement of the required purity and/or. again distilled.

This methods leads to low thermal output expenditure, is thus very much economic feasible, and it lowers danger Verkustung heating surfaces so strong that the plant, becomes performed with which the method a smaller maintenance, operating overhaul or a such. required. Critical one is however that the foregoing advantages become simultaneous with the achievement of an extremely low remainder radioactivity (better than 10 10 Curie/m3) of the final distillate of the plant achieved, those the present high demands, how her initially mentioned are, more becomes than fair.

Preferably the method becomes so embodied that one the vapour condensate of the last stage degassed, before one supplies it or to several preceding stages for evaporation.

To the balance of the quantity balance within the plant one can partly lead back the vapour condensate into the upstream stages. The last stage becomes in particular with vapours or the several preceding stages of an heated.

Also one can heat or several that the last stage preceding stages with live steam or with vapours from a preceding stage.

The invention becomes appended on the basis some particularly prefered embodiments of evaporation plants working in the direct current, those in the Fig. 1 to 3 shown in principle are, more near explained; show:
Fig. 1 a two-stage evaporation plant, the one stage for the product which can be processed, e.g. radioactive effluent, and a stage for the distillate possess;
Fig. 2 a three speed evaporation plant, which exhibits two stages for the product which can be processed and a divided stage for the distillate; and
Fig. 3 a four-level evaporation plant, which covers two stages for the product which can be processed and two stages for the distillate.

It is first on Fig. 1 respect taken, according to which the product supplied with 1, which is to become processed, e.g.

radioactive effluent, by means of a pump 2 over the line 3 into the heater 4 of the last stage of the evaporation plant pumped becomes, which consists of at least two heatinglaterally connected in series stages. In principle the evaporation plant can consist of an arbitrary number of stages, although in Fig. 1 of the drawing only the last and next to last stage in closer details illustrated is.

For the separation from liquid and vapour from the heater a separator 5 serves 4. This separator can some distillation soils for washing the vapour contain. The vapour cleaned here becomes over the line 6 of a condensation mechanism 7, e.g. an air condenser, to the condensation supplied. With 8 the cooling water entrance into the condensation mechanism and with 9 is the cooling water withdrawal from the condensation mechanism indicated.

The condensate of the condensation and/or. Cooling device 7 over the line 10 at a return divisor to 11 given separator 5 formed of that one over a line 12 back-arrives partially into that for example as washing column, while the other part of the condensate of the return divisor becomes 11 14 fed over a line 13 into a deaerator.

The Dampfzufuhr to the deaerator 14 is with 15 and the condensate drain with 16 indicated. Vapour/gas mixture of the deaerator 14 again becomes over the line 17 the condensation mechanism 7 supplied. In addition of the condensation mechanism outgoing line 18 serves for the vent. This line 18 and the vacuum pump 19 connected to it suggest a possibility for an operation bottom vacuum. The vacuum pump 19 is preferably a steam ejector, so that with 20 the steam supply is to the jet pump and with 21 the gas removal of the jet pump indicated.

The condensate from the deaerator 14, which becomes as mono distillate or distillate 1 referred and over the line 22 and the pump 23 the heater 24 of a preceding preceding stage supplied immediate planned in this line in the present case that, is complete degassed and has an activity, as it is more attainable with single-step plants.

The other reduction of the activity made in the mentioned preceding stage by renewed evaporation in the heater 24 and by deposition in the associated separator 25. A return of the mono distillate from this stage into the last stage is not required, because the enrichment is small. Nevertheless such a return can take place in principle, how 26 indicated by the line is, those from the liquid range of the separator 25 to the heater 4 of the last stage runs and in Fig. 1 only broken shown is.

The vapour from the separator 25 becomes over the line 27 the heater 4 supplied and 4 condensed because of its heat output in the heater. The here obtained condensate, which becomes as Bidestillat or distillate II referred, becomes over the line 28 that heatinglaterally last stage, thus in present cases the heater 4, removed and over one Pump 29 and the line 30 as well as a distillate-cool 31 with 32 from the plant discharged. Over to the outlet the pump 29 connected and/or. by the line 30 branched return line 33 becomes a partial flow of the Bidestillats the balance of the quantity balance into the next to last stage, which is with the present two-stage plant the simultaneous first stage, recycled.

With 34 the cooling water entrance is and with 35 the cooling water withdrawal at the distillate-cool 31 indicated. In addition is at each separator 5 and/or. 25 a circulation line 36 and/or. 37 shown, those to the associated heater 4 and/or. 24 leads. Over the line 38, is 39 provided in which a stop valve, the concentrate of the separator can become 5 from the evaporation plant removed.

Those heatinglaterally first stage becomes usually heated with live steam, which becomes the heater 24 40 supplied over the line, while the condensate formed from it becomes 41 discharged over the line. In addition, it is possible, the vapour of the last stage to the heating of the first stage to use, by one e.g. with the help of a mechanical compressor 40 supplies the vapours from the line 6 compressed and the heating plant room of the heater 24 over the line, so that the vapours become there condensed. Then the condensate vrürde subsequent degassed removed over the line 41 and now producing the Bidestillats into the product area of the heater 24 passed become.

Because the liquid which can be treated in the plant, like e.g. a radioactive liquid, the last stage supplied becomes and this with vapours, i.e. Saturated steam, from the preceding stage heated becomes, comes it in relation to multistage direct current evaporation plants only very delayed to the incrustation of the heating surfaces of the heater 5. If one wants to decrease the incrustation speed in the last stage more other, then a reduction of the boiling temperature of this stage is recommended, as a corresponding vacuum becomes 19 generated by means of the vacuum pump.

It is in this connection noted that the condensed evaporate and/or. Vapour of the last stage not necessarily to the repeated evaporation in the heater 24 of the preceding stage, but with one more than two-stage plant also in a still other in front located stage used will can.

With two-stage evaporation plants, which work after the invention process, a condensate of high purity generated, the mentioned Bidestillat, becomes i.e. and the steam consumption is not with such plants higher as with a single-step plant,

which is heated with live steam.

Are appended two examples for operating values of a two-stage plant, which works according to the invention, given.

Example 1 normal operation
The last stage works bottom normal pressure a corresponding temperature in the condenser 7 of 100 C. The product boiling temperature lies then due to pressure loss and Siedepunktserhöhung with 102 to 1050G in the separator 5. The Heizdauipf of the last stage, i.e. the vapour of the first stage, has a saturated steam temperature of approx. 125 0C with corresponding pressure.

The first stage becomes with reduced live steam of 3 bar, a corresponding temperature of approx. 1450C heated. The mono distillate becomes promoted over the line 22 with its temperature from 1000C to the first stage, while the Bidestillat with its temperature of 125 0C in the distillate-cool becomes 31 cooled with cooling water on 400C.

The heater 4 becomes with a working temperature of 125 to 130 C operated, while the temperature lies in the liquid part of the separator 5 with 1020C. The cooling water at the cooling water entrance 8 of the condensation mechanism 7 has a temperature of 250C, while it has a temperature of 35 0C at the cooling water withdrawal 9. The temperature in the condensation mechanism amounts to for instance 1000C, just like in the upper region of the deaerator 14, during in its heating plant room, in over the line the 15 vapor of approx.

2,8 bar of supplied becomes, a temperature of 1#00C prevails.

In the first stage the heater becomes 24 with an heating temperature of approx. 1450C operated, while in the separator 25 a temperature of 130 0C prevails. The cooling device 31 the cooling water becomes over the line 34 and removed supplied with 25 0C over the line 35 with 35 0C.

Example 2 vacuum operation
In the case of that given result appended given example of a vacuum operation are, the subsequent deviations opposite the above values, like them for the example of a normal operation:
The boiling temperature in the last stage is 82 to 850C, so that the other temperatures corresponding adjust themselves lower.

The heater 4 becomes operated with a working temperature of 1100C, while the temperature lies in the liquid part of the separator with 820C. The temperature in the Konden sowing ion mechanism amounts to for instance 800C, just like in the upper region of the deaerator 14, during in its heating plant room, in over the line the 15 vapor of approx. 1,3 bar of supplied becomes, a temperature of 1100C prevails.

In the first stage the heater becomes 24 with an heating temperature of approx. 1250C operated, while in the separator 25 a temperature of 1100C prevails.

The operating values of the cooling water of the condensation mechanism 7 and the cooling device 31 as well as the temperature of the Bidestillats which can be taken are the same indicated as in the example for normal operation.

It is now on the basis the Fig. 2 in the direct current working a three speed evaporation plant more near explained, with that the last two stages for the product and the first stage, which are divided formed, for the mono distillate provided is, whereby first it is to be noticed that the evaporation plant after Fig. 2 in its last both stages to a large extent as constructed is, as the evaporation plant after Fig. 1, so that here only the deviations opposite Fig. 1 discussed become.

Since now the two last stages for the product are provided, this over the line 3 the heater 24 of the next to last stage supplied becomes. Further the line is 28 to the return divisor 11 guided, and of its line 12 a line 12 branches ', which runs to the separator 25. The line 33 and the pump 29 were omitted, and the line 26 is in Fig. 2 full taken off, since it is a normal production management here. Finally the line is 30 at another location than in Fig. 1 connected, the lines 40 and 41 are different connected, and to the heater 24 is from the preceding stage an additional line guided; with these various, last genann ten deviations more other down in connection with the appended explained first stage one deals still more in greater detail.

The first stage of the evaporation plant after Fig. 2 is as divided stage formed, i.e. it exhibits two heaters 42 and 43, which are 44 connected to a common separator, in addition over one circulation line each 45, 46 with the heaters mentioned connected is.

From a line 47, by means of which 44 removed over a valve 48 condensate can become from the separator, a return line 49 branches, which runs to the heater 24. The line 49 is only broken shown, since in the all in accordance with egg do not nen a return of the distillate of the first stage to the second stage required is; in this respect the Fig becomes on the embodiments concerning the line 26. 1 referred.

The mono distillate becomes the heater 42 22 supplied over the line. This heater becomes 50 heated by means of live steam from the line, whose condensate can become 51 discharged over the line. The vapour from the separator 44 becomes partly the heating of the heater 24 and partly 43 used to the heating of the heater, to which a part of this vapour becomes 24 direct supplied over the line 40 the heating plant room of the heater, while the other part of this vapour arrives over the line 52 branching from the line 40 and a mechanical compressor 53 switched on into this line at the heating plant room of the heater 43. In the heating plant room of the heaters 24 and 43 condensed vapours will over the line 41 bzw.54 a distributor 55 supplied, is 30 connected at whose output the line, over which the Bidestillat after passage by that distillate-cool 31 with 32 removed becomes.

Finally is on the basis the Fig. 3 a four-level evaporation plant explained working after the invention process in the direct current. With this plant the evaporation achievement on four stages is distributed, are provided of which two stages for the product and two stages for the distillate.

The advantages resultant from it consist themselves in particular of the fact that steam and Küilliluasserverbrauch opposite a two-stage plant, like it in Fig. 1 shown is, halved is, and that the heaters and separator of the plant become in contrast to this smaller.

The last two stages of this evaporation plant as formed are fundamental, as the two stages of the evaporation plant after Fig. 1, so that only the deviations opposite this plant more near explained to become also here to need:
First the line becomes 26 just like with the plant after Fig. 2 as normal production management used; further is just like in the plant after Fig. 2 the line 12 ' provided and the line 28 to the return distributor 11 guided, as well as the line 3 to supplies of the product to the heater 24 of the next to last stage connected. On other deviations opposite Fig. 1 becomes with the appended explanation of the two first stages of the evaporation plant after Fig. 3 to be received more in greater detail.

The first stage exhibits an heater 56, which becomes heated over the line 57 with live steam, whose condensate can become with 58 discharged. To the heater 56 a separator is 59 connected, which is in addition 56 connected over a circulation line 60 with the heater.

From the separator 59 a steam line 61 leads to the heating plant room of the heater 62 of the second stage, so that thus this heating becomes body with vapours from the first stage heated. This vapour and/or. its distillate becomes from the heating plant room heats body 62 over the line 63 into the heating plant room of the heater 24 of the third stage passed. In addition the heating plant room of the heater 24 over the line 40 vapours of the separator 64 of the second stage, which is 62 connected to the heater, supplied becomes. In addition the separator 64 is 62 connected over the circulation line 65 with the heater.

Finally the separator 64 over a line 66 can become and a valve planned therein 67 condensate removed, and it is also in principle possible to supply to condensate from the separator 64 by way of those broken shown line 68 the heater 24 although that does not happen generally (see in addition the embodiments to the line 26 in Fig. 1). On the other hand the condensate becomes from the separator 59 62 passed over the line 69 the heater, as far as it does not become 56 guided over the circulation line 60 back the heater.

The Bidestillat becomes the heating plant room of the heater 24 of the third stage 30 removed over the line, those to the location of the line 41 the Fig. 1 steps.

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The liquid in at least one the first stage the subsequent stages, preferably in or several last stages, the evaporation plant and in combination thereby the vapour condensate of these, preferably the latter, stage evaporates claims methods to the evaporation of liquids, in particular of radioactive effluents, by means of multistage evaporation plants, characterised in that one and/or. Stages in or several this stage and/or. these stages evaporates preceding stages to the achievement of the required purity and/or. again distilled.

2. Process according to claim 1, characterised in that one the vapours of the last stage and/or. Stages condensed, before one supplies it as condensate or to several preceding stages.

3. Process according to claim 2, characterised in that one the condensate degassed, before one supplies it or to several preceding stages.

4. Process according to claim 1, characterised in that one the vapours of the last stage and/or. Stages compressed, preferably with the help of a mechanical compressor, and in the heating plant room of a preceding evaporation stage condensed.

5. Process according to one of claims 1 to 4, characterised in that one the condensate partly into the last stage and/or. Stages leads back.

6. Process according to one of claims 1 to 5, characterised in that one or several preceding stages distillate and/or. Condensate from the last stage and/or.

from the last stages to the balance of the quantity balance supplies.

7. Process according to one of claims 1 to 6, characterised in that one the last stage and/or. the last stages with vapours or the several preceding stages of an heated.

8. Process according to one of claims 1 to 7, characterised in that one or several that the last stage and/or. the last stages preceding stages with vapours from or several preceding stages an heated.

9. Process according to one of claims 1 to 7, characterised in that one or several that the last stage and/or. the last stages preceding stages with live steam heated.

10. Process according to one of claims 1 to 9, characterised in that at least the last stage of the evaporation plant bottom vacuum with low boiling temperature operated becomes.

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